COTTONSEED HANDLING AT GINS

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COTTONSEED HANDLING AT GINS

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Although cotton has been grown for its fiber for many centuries, the seed has been generally used commercially only in relatively recent times. It is reported that in ancient times the Hindus and the Chinese, using the principle of the mortar and the pestle, developed crude methods for obtaining oil from cottonseed. They used the oil for their lamps and fed the remainder of the pressed seed to their cattle. For many centuries, however, the use of cottonseed in India and China never developed much beyond that primitive stage.

The first cottonseed oil known to have been produced in America was exhibited before the American Philosophical Society in 1768. It was produced on a very small, experimental scale and was generally regarded as a curiosity. Little effort appears to have been made to produce additional oil until after the invention of the cotton gin in 1793. The increase in cotton production that followed this invention made the use of cottonseed a challenge.

During the first part of the 19th century, mills in Europe began to crush Egyptian cottonseed on a limited scale. However, American chemists were primarily responsible for transforming cottonseed into useful products.

Before the crushing industry was developed, cottonseed had no cash value except the limited quantities sold for planting-seed. Small quantities of seed were used for fertilizer and some was fed to livestock. Raw cottonseed, however, has limited value as livestock feed. Most seed was left at the gins. Disposal was a serious problem; some States passed laws prohibiting gins from accumulating large quantities on their premises and from dumping seed into streams.

What is believed to be the first commercial undertaking to crush cottonseed on a large scale was a mill established at Natchez, Miss., in 1834. Several other mills—at Raleigh, N.C., Florence, Ga., and Mobile, Ala.—were established about the same time. All failed.

The development of satisfactory oil milling equipment, however, solved the major technical problem that had faced the early mills, and made the processing of cottonseed economically practicable. Significant expansion followed.

The Census of 1870 reported 26 cottonseed crushing mills in operation. This number increased to 45 in 1880 and to 119 in 1890. There are now (1962) approximately 200 mills in operation.

As mills were established, cottonseed acquired a cash value. The first price reported was $5 per ton in 1860. This price was paid, however, only at a few Mississippi River points, from which seed could be readily transported to the few mills then operating. It was

many years before farmers in all parts of the Cotton Belt could sell their seed for cash. In fact, not until the turn of the century (1899) was more than half the crop crushed.

As markets developed for cottonseed products and the number of mills increased, the quantity and value of seed crushed rose steadily. Cottonseed became the third leading source of cash income in the Cotton States, being exceeded in value only by cotton lint and tobacco. During recent years, the farm value of cottonseed has averaged $320 million annually—about 12 percent of the total value of the cotton crop (*4*).[1]

TYPES OF COTTONSEED HANDLING SYSTEMS

Seed at gins may be handled readily by gravity, belts, screw conveyors, or pneumatic piping. The seed can be kept pure by several of these methods. The belt and blowpipe types of conveying systems are self-cleaning, but screw conveyors must be hand-cleaned between the ginning of different varieties. For other than single-variety gins, belt or blowpipe conveyors are therefore desirable if an appreciable quantity of seed is to be saved for planting.

Where vertical lifts are employed, screw elevators are generally more efficient and sturdy. Bucket elevators often have troubles with slipping belts and faulty alinement. In some instances seed and trash may be conveyed by belts and piping. Conveying seed by air in small pipes is now the most efficient and economical method (*2*).

COTTONSEED CONVEYING WITH SMALL AIR PIPES

The small-pipe system for conveying cottonseed provides an economical method for handling seeds and granular bulk materials (*1*, *6*).

Two improved types of seed-pipe handling systems have been developed and tested at the U.S. Cotton Ginning Research Laboratory, Stoneville, Miss.: (1) A pressure or "blow-through" method, utilizing 4- to 6-inch pipes with rotary air pumps and turboblowers; (2) a suction or "draw-through" method, using 7- to 9-inch pipes with a high-speed, low-pressure cotton-gin fan and a separator of special design. The first method has proved better adapted to long runs of piping, more economical, and free from trouble; and it is advocated by the U.S. Department of Agriculture for pure-seed handling.

Small-pipe systems are excellent for operating economy and freedom from trouble. They enable the cotton producer and ginner to preserve the purity of the cottonseed because the apparatus is self-cleaning. They have adequate capacity for removing up to 160 pounds of cottonseed per minute, as fast as the cotton is ginned. Being light in weight, they may be stationary or portable and are a significant labor-saving means for quickly unloading trucks into railroad cars and for emptying the cars at seed-breeders' treating and delinting plants. They may also be used for conveying seed to storage bins and for moving it later for grading, sterilizing, and other processes at rates to suit capacity of the plant. Cottonseed has been handled success-

[1] Italic numbers in parentheses refer to Literature Cited, p. 23.

fully by these small-pipe blowing systems for distances up to 700 feet, at approximately half the cost for operating power of larger pipe and fan methods.

A stationary small-pipe system is shown in figure 1. A self-cleaning seed belt is used to feed the system dropper that introduces the seed into the air pipe, a tight valve enables the operator to divert the seed to truck bin or to storage, and flanged piping and elbows provide the piping runs to points of delivery.

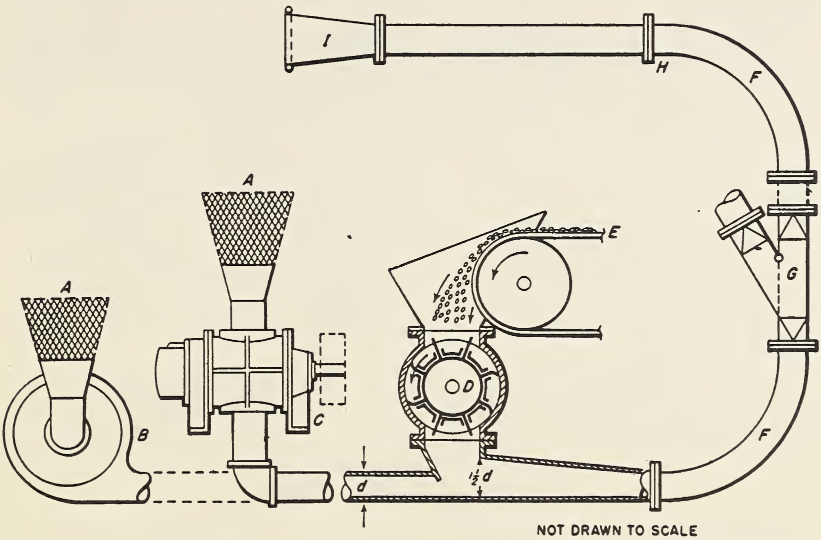

FIGURE 1.—Small-pipe system for cottonseed: *A*, 16-mesh air filter, or screen box; *B*, turboblower; *C*, rotary positive blower; *D*, dropper, or vacuum-wheel feeder with 8 or more shallow pockets; *E*, gin-stand seed belt; *F*, long-sweep, 36-inch radius elbows; *G*, valve for diverting seed to bin or storage; *H*, 6-bolt flange and rubber gasket; *I*, funnel discharge for efficient delivery. Diameter at *d*, 4 inches for 1 to 3 stands; 5 inches for 4 to 6 stands.

Air-Conveying Principles and Calculations

Pipes of 4- and 5-inch diameter have proved large enough for handling cottonseed in average gins and delinting plants. The 4-inch piping is sufficient for handling up to 3 tons of seed per hour. The 5-inch is recommended for handling up to 6 tons of seed per hour.

For preliminary calculations to determine the total resistance pressures that the pump or blower must overcome, it is customary to allow 16 ounces' resistance (or 1 pound per square inch) for each 200 linear feet of piping. In calculating, each short elbow and each valve must be considered equivalent to approximately 15 feet of straight pipe. For more accurate approximation, on which the factory can provide the blower unit and suggest its speed, add up the pressure losses for the individual elements that make up the system as follows:

	Pressure allowance per sq. in. (ounces)
4-inch piping, each 100 feet	6
5-inch piping, each 100 feet	5
For both 4- and 5-inch pipes:	
Elbow and valve, each	0.8
Base and tapered discharges from dropper	2
Cyclone collector and sacker at end of pipe	1

This estimate is based on a velocity of 4,500 feet per minute, with volumes of 405 and 650 cubic feet per minute for 4- and 5-inch pipes, respectively.

Satisfactory mean or average air velocities within small seed pipes range from 4,200 to 5,200 feet per minute. Relatively small air volumes—about 4 cubic feet per pound of cottonseed for rotary positive-pressure blowers only— have been satisfactory in short piping systems, but it is advisable to allow 5 cubic feet where piping exceeds 250 feet or where turboblowers are used. Since the velocity and volume of a conveying air stream depend on the average size and specific weight of the material being moved, these rules apply only to cottonseed.

For horizontal blowing of cottonseed, the lower limit of air velocity in the pipe should be not less than 4,000 feet per minute; any addition of elbows and risers necessitates an increase in air speed to within the ranges given above. No seed should pass through the blowers, regardless of the kind of system.

Since air leakage usually results in unsatisfactory operation of these systems, the joints should always be tight and the valves and feeders well sealed.

Blowers and Air Pumps

Existing practices at cotton gins include the general use of low-pressure air piping, ranging in diameter from 8 to 14 inches, operating with cotton-gin fans against 10 to 16 inches' resistance pressure as measured on a U-tube water gage. Since operating air pressures for small-pipe systems usually vary from 1 to 3 pounds per square inch, it is necessary to use either slow-speed positive-pressure rotary air pumps or high-speed centrifugal turboblowers. Common fans cannot serve for this purpose. The two-lobe rotary air pump (fig. 2) is the type most commonly used and is known to the trade as a positive-pressure blower. Although the standard practice with liquids has been to place the suction intake on the underside and the discharge on the top side of the rotary pump, there are many advantages in reversing the method in seed handling. With the discharge underneath, dust and moisture are continually expelled from the blower, thus lessening wear and damage.

Single-stage, centrifugal turboblowers (fig. 3) that may be either belted or direct-connected and run at 3,500 revolutions per minute are used by various industries where the air pressures do not exceed 3 pounds per square inch. They weigh, with motor, 350 to 500 pounds, compared with 400 to 550 pounds for the bare rotary pump.

The rotary positive-pressure blower is recommended for stationary installations where unskilled labor may tend to feed cottonseed in lumps or where handling is irregular or intermittent. This type of blower can purge the piping to overcome minor chokages by a tempo-

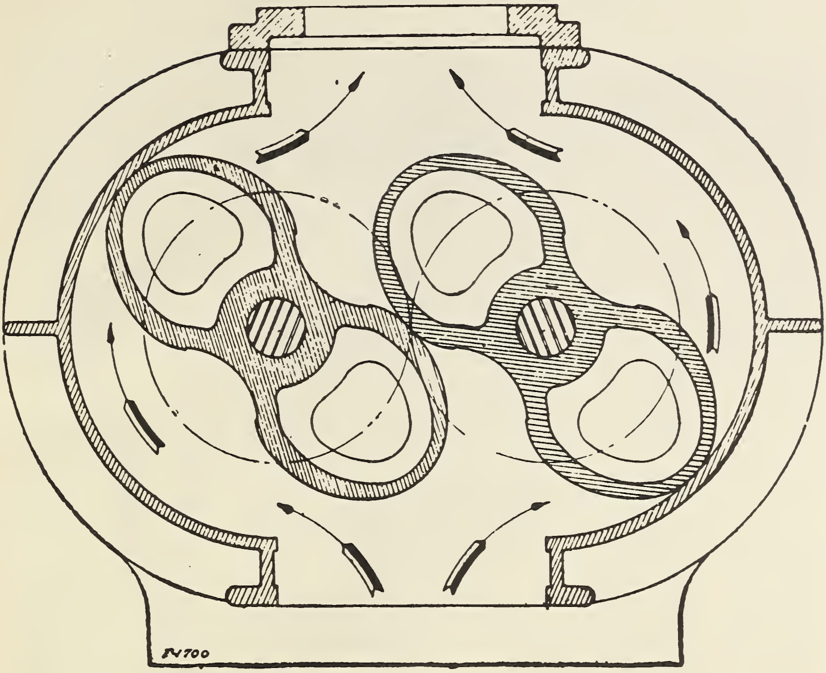

FIGURE 2.—Cross section of typical positive-pressure 2-lobe rotary air pump used for conveying cottonseed. Rotation may be reversed if desired.

rary buildup of sufficient air pressure. The choice of this type of air pump seems also to be advisable where the pipe runs are more than 200 feet long.

For portable and short piping installations, the centrifugal turbo-blower unit can be used advantageously, and by means of temporary flexible connections it can be made to serve in numerous ways with profit.

Several portable units for loading and unloading cottonseed are on the market; they are similar in design to the unit developed at the U.S. Cotton Ginning Research Laboratory, Stoneville, Miss. (fig. 4).

Performance data are given in table 1 for the rotary positive-pressure blowers now being used successfully at cotton gins and seed establishments.

Devices on Inlets and Outlets of Blowers

A screened intake, or air filter, is necessary on cottonseed-handling blowers to protect the lobes and casing from excessive wear and to prevent wisps of fiber and foreign matter from damaging and unbalancing high-speed blades. Screened-intake types of filters may be either factory-built or homemade. Large areas of close-mesh bronze screen wire are necessary for homemade intake filters; they should have at least 5 square feet of gross screen area, all accessible for daily or more frequent cleaning.

TABLE 1.—*Performance data for rotary positive-pressure cottonseed blowers*

[Adapted from published tables of manufacturers]

Seed capacity	Size [1]	Pipe diameter	Speed	Pressure					
				1 pound [2]		2 pounds [2]		3 pounds [2]	
				Volume	Power	Volume	Power	Volume	Power
	No.	*Inches*	*R.p.m.*	*Cu. ft.*	*Hp.*	*Cu. ft.*	*Hp.*	*Cu. ft.*	*Hp.*
Up to 90 pounds per minute	615	4	575	325	2.0	300	3.8	280	5.7
			615	350	2.1	325	4.1	310	6.1
			690	400	2.3	375	4.6	360	7.0
Up to 160 pounds per minute	717	5	490	480	2.8	450	5.6	425	8.5
			575	570	3.2	540	6.5	515	9.7
			690	700	4.0	670	8.0	650	12.0
			717	730	4.1	690	8.2	670	12.3

[1] One of several trade designations.
[2] 4 cubic feet of air per pound of seed may be allowed at 1-pound pressure. At all higher pressures, allow 5 cubic feet.

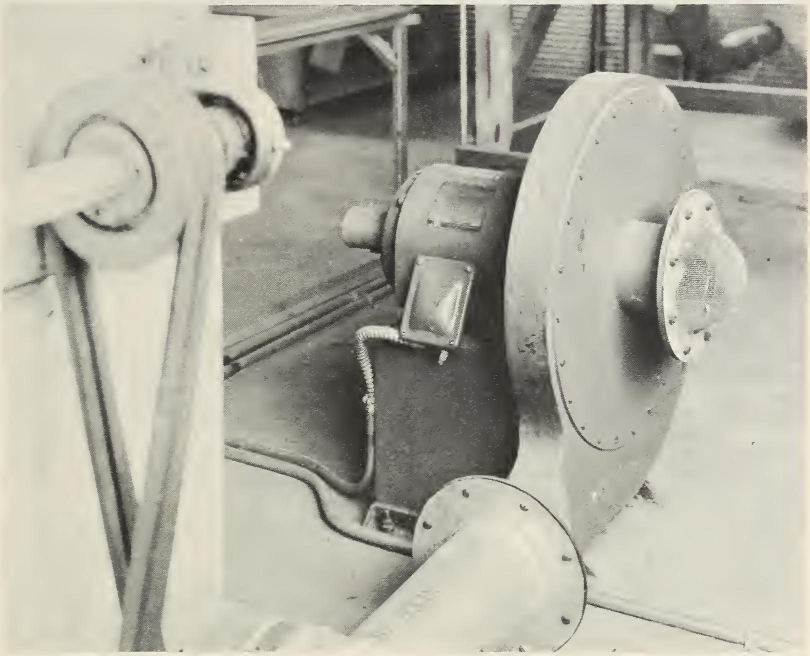

FIGURE 3.—Single-stage motor-driven centrifugal turboblower suitable for handling cottonseed.

Relief valves are seldom used on positive-pressure blowers, because they prevent purging the system at momentarily higher pressures when chokages threaten. If used, they should be set to pop off at double the working pressures.

Centrifugal turboblowers are obtainable with a blast gate or butterfly type of control valve on the blower outlet, so that adjustment can be made to prevent overloading the motor. Since the outlet diameter of cottonseed turboblowers is usually 6 inches, the control valve becomes a necessary adjunct to the regulation of the 4- and 5-inch seed lines used at cotton gins, and it also is a desirable device for portable short-run installations.

An air-pressure gage on the outlet of all seed-handling blowers is recommended, so that the operators may be aware of excessive pressures and regulate their units more efficiently.

Feeding Seed Into Pressure Pipes

Cottonseed may be satisfactorily fed into a small-pipe pressure system by means of a dropper, or rotary sealed wheel (sometimes called a vacuum wheel). This facilitates dropping the seed mechanically into the air line on the discharge side of the pump or blower. Handling cottonseed by suction requires a special separator. But the expense of a separator is not warranted unless the rate approaches 40 tons or more per hour, in which case motors up to 75 horsepower and extremely large blowers are needed.

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FIGURE 4.—Portable cottonseed unloader.

Speeds of the rotary sealed wheel, or dropper. should be relatively low—30 to 60 revolutions per minute—and internal seals at the ends and pocket divisions are necessary to prevent serious air leakage. A machined dropper should handle up to 4½ tons of cottonseed per hour at normal speed with 5-inch piping connections. It is customary to provide an independent drive for the dropper, because its speed is much slower than either a rotary positive blower or a centrifugal turboblower. A taper of 20 inches or more should be used on feeder base outlets to prevent chokage, and must be set as close to the feeder as possible.

Piping

Standard 20-gage galvanized pipe or galvanized lightweight tubing is recommended where the piping is to be exposed to the weather.

Joints should be flanged wherever seed passes through the pipe. Six-bolt companion flanges with rubber gaskets are recommended. On the blower intake and discharge or at points ahead of the seed dropper, standard screwed pipe and fittings can be used for handling the compressed air.

Seed-handling elbows should be 18-gage or heavier and of long sweep. A radius of 36 inches is recommended for pipes 4-, 5-, and 6-inches in diameter to provide satisfactory service without chokage.

Risers, or lifts, in seed piping should preferably be on an incline rather than vertical, to use minimum angles at elbows and to save the piping length that diagonals afford in comparison with right-angle runs.

Valves, Branches, and Discharges

Valves for small-pipe systems frequently give trouble in operating. They require good workmanship and must be properly fitted to insure against leakage. Not more than two valves should be used in the ordinary cottonseed system, because leakages and careless adjustments invariably invite trouble.

In the design of vane-type seed valves (*G* in fig. 1), the takeoff angle should not exceed 30°. The deflector vane should be of adequate thickness, and should be well fitted into the body of the valve, with the seated end so adjusted that seed chokage will not be caused by lint or seed building up at the valve intake.

The discharge funnel (*I* in fig. 1) materially assists airflow through the pipe to open bins, but it should not be aimed at a blank wall or at any object that might cause cracking of the seed.

Cyclone collectors of seed for delivery to sackers may be used at the ends of small-pipe systems. The downspouts from these collectors should be 8 inches or more in diameter to prevent chokage or bridging of seed at the base of the collectors.

Other Features of Small-Pipe Systems

Distances for conveying cottonseed with low- or medium-pressure systems—1 to 6 pounds' pressure per square inch—are limited between approximately 200 and 700 feet of piping length. Since no two systems are quite alike in length and in number of risers and elbows, the limitation of pressure and volume incident to the type of blower must be carefully considered in the design of any small-pipe system.

Power cost is usually about half that of customary cotton-gin fan systems. Initial cost of small-pipe systems using positive-pressure blowers is somewhat lower than the gin fan system.

COTTONSEED WEIGHING OR MEASURING EQUIPMENT [2]

Most modern gins are equipped with seed scales for weighing cottonseed from each bale as ginned (fig. 5).

A comparatively new type of cottonseed measuring device has been placed on the market in recent years. It consists of a small water-wheel type device which receives the seed from the gins, and dumps automatically when each succeeding pocket of the wheel has received a predetermined amount of seed (figs. 6 and 7). Each pocket of seed is automatically counted and recorded as it is dumped, and the device can be equipped to signal the completion of each bale.

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[2] The mention in this publication of commercially manufactured equipment does not imply its endorsement by the U.S. Department of Agriculture over similar products not named.

From these weighing or measuring devices the seed is conveyed by air, auger, or lift, to trailer bin, seed storage, railroad car, or for special processing such as sterilizing, delinting, and treating.

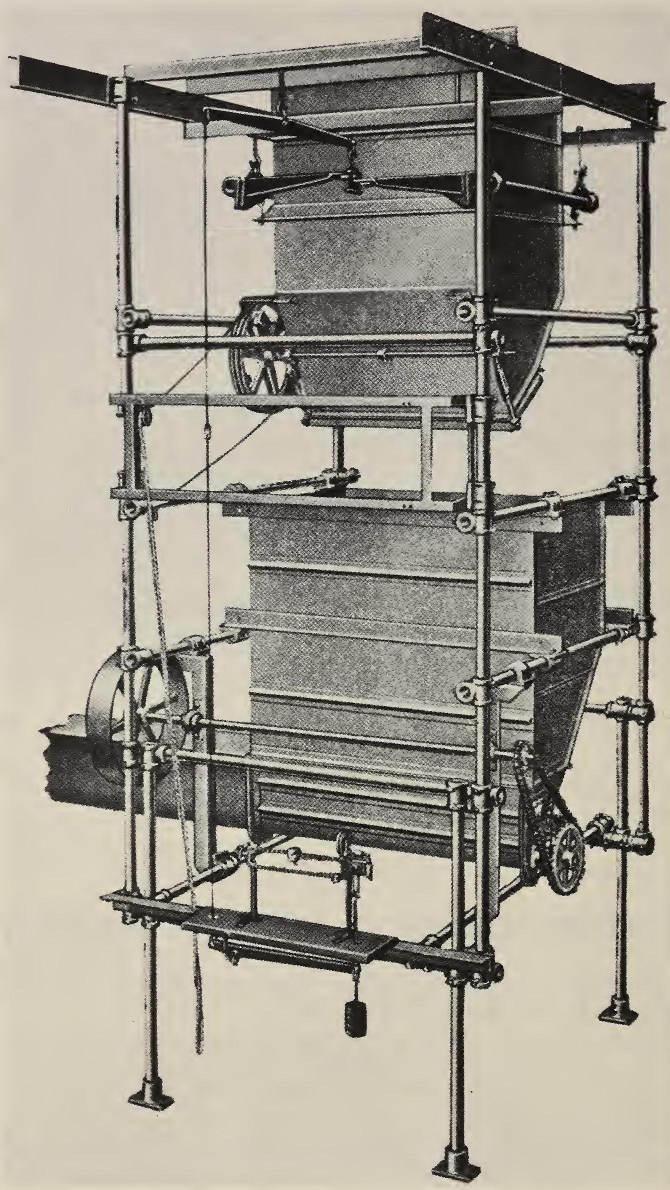

FIGURE 5.—Cottonseed scales for use in cotton gins. (Courtesy Murray Co.)

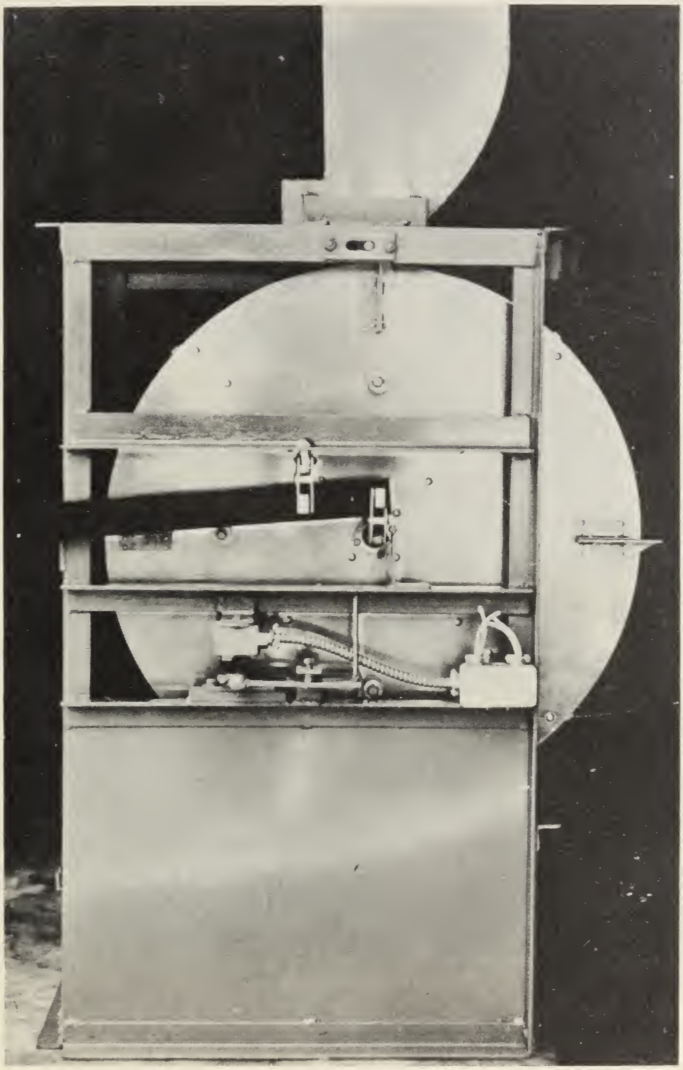

FIGURE 6.—Outside view of water-wheel type measuring device for cottonseed. (Courtesy Crow Scales, Inc.)

HANDLING COTTON PLANTING-SEED AT GINS

Cotton planting-seed usually is delinted and treated in the storage period between the time of ginning and the next planting season (*3*). During this period, ownership of the planting-seed remains with the producer.

FIGURE 7.—Cottonseed recording and signaling device. (Courtesy Crow Scales, Inc.)

About 300,000 tons of cotton planting-seed are required annually in the United States, in addition to emergency replanting demands. Both large and small producing communities are frequently in need of information on the best handling methods.

Processing cotton planting-seed, including storage, bulk cooling, grading, cleaning, delinting, and treating, is practiced at cotton gins where purity and preservation of the seed are important adjuncts to sales. The methods are applicable on the farm as well as at the gin. All are safeguards against foreign matter, excessive moisture, plant diseases, and other causes of loss in quality. Each method may assume special importance to cotton producers in meeting regional variables encountered in the preservation and improvement of quality.

Storage

Shelter for cotton planting-seed usually is provided in storage houses. Table 2 gives the capacity of storage houses of various dimensions. Without being heavily packed, cottonseed usually requires about 80 cubic feet of space per ton, and 1 cubic foot of cottonseed thus weighs about 25 pounds. For best results from cooling systems, experienced seed breeders do not advise storing planting-seed containing more than 12 percent of moisture to a depth exceeding 8 feet.

Producers of pedigreed and certified planting-seed have found that cottonseed should be dried to a moisture content of 12 percent or below before it is placed in bulk storage. They also suggest that at least a 60-day rest period in storage is desirable for freshly ginned seed before samples are taken for accurate germination tests.

The fact that seed may have undergone a 10-day storage period without undue heating or damage is no guarantee that it will continue to keep. A gradual increase of free fatty acid can develop by almost imperceptible temperature rises. Fluctuations may occur in seed temperatures within ranges of 10° or 12° as the weather changes, and yet the general trend of moisture content may be downward if the moisture content of the seed was below 12 percent when it was put in storage. For all practical purposes, *12.0-percent moisture content* is the danger point for seed in storage unless it is aerated and kept cool. Every effort should be made to bring the moisture content of all stored seed down to at least 11 percent as soon as possible. The bulk storage system advocated by the U.S. Cotton Ginning Research Laboratory is delineated in figure 8 and is being satisfactorily used for cottonseed.

Cooling and Airing

The type of construction used in the storage house will dictate the choice of cooling system. Enclosed sheds with wooden floors are common; some are provided with underspace, and some have a hall between two rows of bins. Another type of storage house is elevated on sturdy posts above a driveway, so that trucks may drive under the storage space and receive seed through trapdoors. A third type, for storing seed in either bulk piles or bins, consists of a metal-sheathed shed erected on a concrete slab. The slab may be on the ground, or it may be on footing walls and earth fill. In the latter, underfloor laterals from a centrally located suction tunnel, either above or below floor level, may use suction holes through the floor for cooling and airing the seed.

Several good systems are shown in figures 8 to 11. Each is satisfactory; loss of seed is extremely low in such installations.

If the storage house has a removable grid floor or laterals (as shown in figs. 8 to 11), the building may be used for other purposes during the period between planting and harvesting. Other seeds and grains can be handled readily with the cooling system, but methods of filling the storage space may differ.

For bulk cooling of cottonseed, 3,333 cubic feet of air per minute should be allowed per ton of seed for each 1 percent of drying effect desired per hour. This drawing of the air through the seed must be done during daylight hours in fair weather only, and then preferably

TABLE 2.—*Capacity of cottonseed storage houses of various dimensions* [1]

Inside width (feet) [2]	Capacity per linear foot	Capacity, when length of house is—									
		20 feet		40 feet		60 feet		80 feet		100 feet	
	Tons	*Tons*	*Bushels*	*Tons*	*Bushels*	*Tons*	*Bushels*	*Tons*	*Bushels*	*Tons*	*Bushels*
18	1.8	36	2,300	72	4,600	108	6,900	144	9,350	180	11,500
20	2.0	40	2,600	80	5,200	120	7,800	160	10,400	200	13,000
22	2.2	44	2,850	88	5,700	132	8,550	176	11,400	220	14,250
24	2.4	48	3,100	96	6,250	144	9,350	192	12,500	240	15,500
26	2.6	52	3,400	104	6,750	156	10,150	208	13,500	260	16,900
28	2.8	56	3,650	112	7,300	168	10,900	224	14,550	280	18,200
30	3.0	60	3,900	120	7,800	180	11,700	240	15,600	300	19,500
32	3.2	64	4,150	128	8,300	192	12,450	256	16,600	320	20,800
36	3.6	72	4,600	144	9,200	216	13,800	288	18,400	360	23,000

[1] Based on loosely packed seed (estimated volume, 80 cubic feet per ton). Tightly packed seed has an estimated volume of 71 cubic feet per ton.

[2] Plate height, 19 feet; average depth of seed pile, 8 feet.

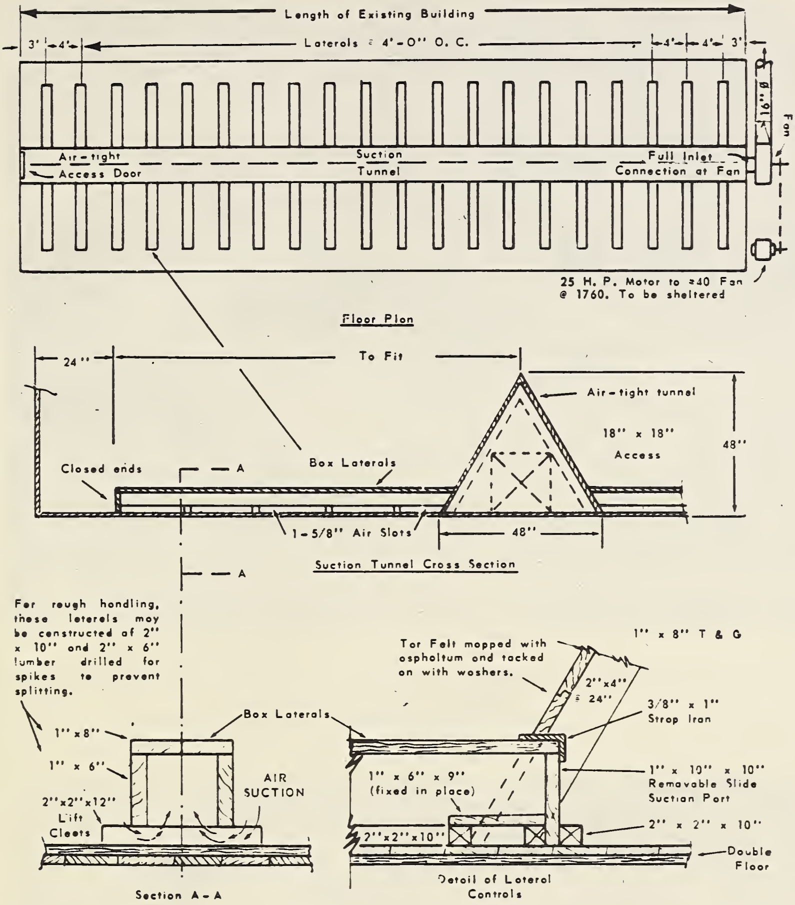

FIGURE 8.—Diagram of central triangular tunnel and laterals for seed storage. If side access doors are provided at intervals a seed belt or auger may be used within the tunnel to empty any part of the seed house.

between 10 a.m. and 4 p.m. For large volumes of seed, the time may be lengthened proportionately so that the volume of air allowed per ton of seed per hour is reduced in order to spread the drying to more seed. For example, if 1,111 cubic feet of air per minute is allowed per ton of seed, 3 hours of drying will reduce the moisture content 1 percent.

In planning for air delivery or suction systems for cooling cottonseed in bins and drying it without heat, the element of time and the initial moisture content of the seed are important. As stated earlier, the moisture content of the cottonseed should be reduced below 12 percent for safe storage.

As a rule of thumb, a No. 35 cotton-gin fan with 18 blades will deliver 3,500 cubic feet of air per minute against a resistance of 5 inches (as shown on a U-tube water-pressure gage) at a speed of approxi-

FIGURE 9.—Removable box laterals, 4 feet apart on centers, plugged into a side tunnel or suction trunk.

FIGURE 10.—Removable grid or lattice floor, with side tunnel or suction trunk. This system can be used for either bulk or sacked seed.

FIGURE 11.—Removable grid or lattice floor, with seed stored in sacks for air cooling and drying.

mately 1,333 revolutions per minute (table 3). A No. 35 fan with 6 or 8 straight blades and a fan wheel 32 inches in diameter will deliver 3,500 cubic feet of air at a speed of about 1,000 revolutions per minute.

At a given speed, the volume (cubic feet of air delivered per minute) of a centrifugal fan increases as the resistance it has to overcome decreases, and there is a corresponding increase in horsepower consumption. Therefore, the type of cooling fan and size of motor are of major importance in the satisfactory and economical operation of a cooling system. Backward pitch blades to fan wheels with load-limiting characteristics are the advisable types to choose. Also, it may be advisable to consult cotton-ginning specialists of the U.S. Department of Agriculture regarding fan problems.

Suction resistance in pulling air through cottonseed is given in table 4.

Delinting and Treating

All freshly ginned seed should be cleaned, to remove lightweight seed and trash, before it is delinted and treated. For low cost and best operation, grading, culling, and cleaning should be followed by delinting and treating in a continuous operation. To prevent rehandling, there should be a reasonable working balance in the relative capacities of graders, cleaners, and delinting and treating machines. Several kinds of satisfactory equipment are on the market.

Mechanical Delinting Machines

The short fibers (linters) that adhere to the cottonseed after ginning are removed from the seed at the oil mill to make it easier to extract

the oil. Delinting machines have gradually been increased in size from 106 saws per delinter to 141, and then to 176. Thus, new and used equipment for delinting cotton planting-seed is available in three sizes.

Machines with 141 saws range in capacity from ½ to ¼ pound of cotton linters per saw per hour, or approximately ¾ bushel of planting-seed per hour for each 10 saws.

Successful community delinting and treating plants are in operation in each region of the Cotton Belt. Some of these plants are using discarded delinting machinery from local cotton-oil mills.

TABLE 3.—*Comparative data on cotton-gin fans of different sizes for drying seed in piles or bins* [1]

Type of fan	Fan wheel		Revolutions per minute	Volume [2]
	Blades	Diameter of wheel		
	Number	*Inches*	*Number*	*Cubic feet*
Type C:[3]				
No. 35	18	23.5	1,333	3,500
No. 40	18	27	1,126	4,000
No. 45	18	30	1,000	5,100
No. 50	18	33	906	6,252
Plain:[4]				
No. 35	6 or 8	32	1,000	3,500
No. 40	6 or 8	32	1,000	4,000
No. 45	6 or 8	32	1,000	5,000
No. 50	6 or 8	32	1,000	8,000

[1] Based on a seed-pile depth of 8 feet.
[2] Air delivered per minute against an estimated resistance of 5 inches as measured on a U-tube water gage.
[3] Courtesy of Clarage Fan Co.
[4] Courtesy of Boardman Co.

TABLE 4.—*Suction resistance in pulling air through cottonseed, with a starting air volume of 4,000 c.f.m.*[1]

Depth of cottonseed	Resistance of cottonseed with a moisture content of—		Depth of cottonseed	Resistance of cottonseed with a moisture content of—	
	13 percent [2]	10 percent [3]		13 percent [2]	10 percent [3]
Feet	*Inches*	*Inches*	*Feet*	*Inches*	*Inches*
0	0.0	0.0	8	0.7	0.6
1	.3	.3	9	1.0	.7
3	.4	.4	10	1.0	.7
4	.4	.5	11	1.2	.8
5	.6	.5	12	1.7	.9
6	.7	.5	13	2.5	1.0
7	.7	.6			

[1] Cottonseed had been in storage 6 months.
[2] Average resistance per foot=0.19 inch of water.
[3] Average resistance per foot=0.08 inch of water.

Overhead seed distributors to delinter feeders may be either belt-type or auger-type conveyors. Auger-type conveyors combine self-cleaning lifts with horizontal runs.

Power Requirements

Power requirements for each delinting machine and feeder range from 10 to 15 horsepower; for the overhead distributing system, from 5 to 7½ horsepower; for fans, an estimated 4 horsepower; and for seed-treating machines equipped with fans, ¾ to 3 horsepower. Information on power requirements of delinting and treating equipment may be obtained from the manufacturer.

EFFECTS OF DRYING SEED COTTON AT THE GIN ON COTTONSEED IN STORAGE

The conditions under which cottonseed is stored have an important bearing on the quality of the seed after prolonged periods of storage (5). Excessive moisture content and overheating of the seed not only have an ultimate adverse effect on the quality of oil extract from stored seed but also may influence germination.

In 1939, unconfirmed reports came to the U.S. Cotton Ginning Laboratory that the process of artificially drying seed cotton at gins presented serious problems in seed storage at oil mills and caused undesirable increases in the free fatty acid content of the seed. Studies designed to duplicate the conditions of oil-mill and cotton-gin seed storages were made in an effort to obtain data under controlled conditions to refute or confirm these reports.

Results of the 2-year study have been compiled and analyzed. They indicate that with green, damp, or wet seed cotton, the process of artificially drying before ginning did not increase the rate of deterioration of the seed in storage; in fact, it retarded the formation of free fatty acids. The higher the drying temperature, the lower the free fatty acid content of the seed at the end of the 90-day storage period.

The seed from cottons picked and ginned in a dry condition did not show a significant change in free fatty acids during 90 days of storage, and the added removal of moisture by artificial drying therefore did not affect this property in the dry seed.

Artificial drying of seed cotton at the gin, where the ginned seed was 12 percent or higher in moisture content, caused slight temperature increases in the seed. In a few days, however, natural cooling eliminated most of the differences in temperature, and thereafter the seed ginned from undried, damp cotton was only slightly higher in temperature than that from dried, damp cotton. Seed from undried and dried cotton of low moisture content maintained practically the same temperatures in storage.

Drying wet cotton at time of ginning with an air temperature of 220° F. removed a maximum of 0.7 percent of moisture in the seed. At the end of 90 days' storage, the difference in moisture content between undried and dried seed was reduced somewhat; the undried seed lost 1.2 percent of moisture and the seed representing the high drying temperature, 0.9 percent. In the seed ginned from the dry cotton, very little difference in moisture content was noted at the end of the

storage period. The dried seed gained moisture, the undried seed lost moisture, and all ultimately reached the same level of moisture content.

Germination tests on the undried and dried seed indicated that drying improved the percentage of germination, whether at time of ginning or after 90 days' storage.

Cottonseed that developed high free fatty acid content seemed to have a tendency toward low germination. The data indicate that a free fatty acid content of 2 percent becomes critical so far as cottonseed germination is concerned.

The effect of conveying the seed from the gin stands to storage by means of unheated and heated air was very slight. As compared with conveying on a flat belt, unheated air used to move the seed caused a slight decrease in seed temperature. Conveying air heated up to 180° F. resulted in an increase of only a few degrees in the seed temperature for seed 12 percent or higher in moisture content. These increases were only temporary, and temperature returned to normal in 3 or 4 days.

In most instances the use of air in conveying the seed caused a slight reduction in moisture content of wet seed, but the reductions were generally too small to be significant. The moisture and temperature effects were also insignificant with dry seed; and the free fatty acid content and germination of both wet and dry seed after 90 days' storage were not materially affected by the different methods of conveying the seed.

USDA-DEVELOPED COTTONSEED DRIER FOR USE AT GINS

Extensive programs of research embracing cottonseed drying, cleaning, and sack and bulk storage were carried out over a period of years at the U.S. Cotton Ginning Research Laboratory, Stoneville, Miss. The tests centered around the development of a cottonseed drier, designed and fabricated at the Laboratory (*7*), made up of inclined, revolving, perforated cleaning drums equipped for heated air application and subsequent cooling (figs. 12 and 13).

Description of Drier

The flow of seed from the cotton gin is directed into a feeder mounted above the drier, which provides for the delivery of the cottonseed into the drier.

The uppermost section of the drier consists of two drums, with the inner drum having large perforations and arranged so as to revolve inside the outer drum. The smaller inner drum with its large perforations permits the cottonseed to pass into the outer drum but retains the large trash consisting mainly of hulls and grabbots, and conveys this into the trash discharge. The outer drum slowly conveys the cottonseed, while drying, into the next drum immediately below but in the same drying chamber. The smaller perforations in the outer drum and the second large drying drum permit the smaller trash to pass into the trash conveyor for discharge. Again, the seed is slowly conveyed until it reaches the end of the drum and is discharged in a steady flow into the cooling drum, where unheated air is pulled

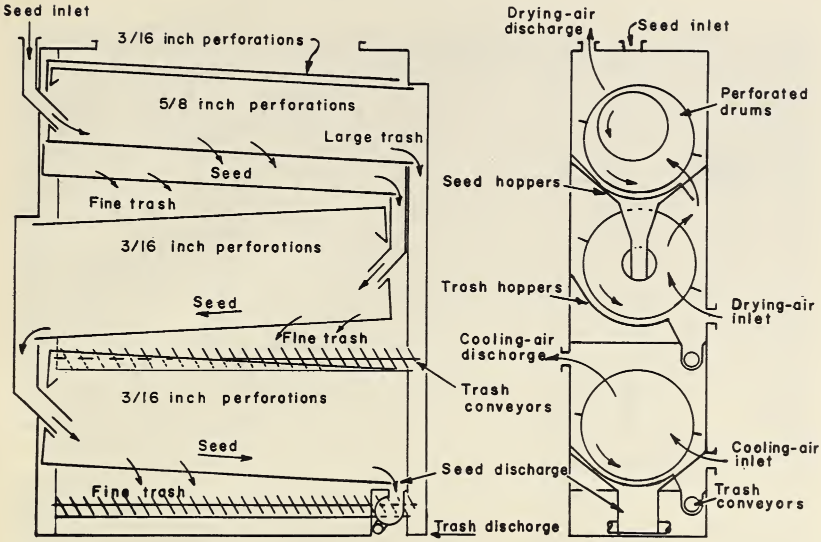

FIGURE 12.—Cross section of USDA-developed cottonseed drier.

in at the rate of 7,000 cubic feet per minute. The cooling drum also has small perforations which permit the sifting out of small trash while the seed is carried to the end of the cooling drum for final discharge into the seed line.

An average of 4 minutes is required for the seed to pass through the drying drums. The seed is then exposed for 2 minutes of cooling during passage through the cooling drum before it reaches the final discharge.

A 1-million B.t.u., gas-fired burner is used with the cottonseed drier to heat approximately 5,000 cubic feet of air per minute, the air being supplied by a low-horsepower, high-volume fan of suitable size. The hot air intake to the drying chamber is provided with directional vanes to give good distribution of the hot air the full length of the drier. The cool air intake should be provided with a ⅛-inch mesh screen for protective purposes.

Operation of Drier

The drying air temperature should be regulated to produce an internal cottonseed temperature not to exceed 140° F. To do this, the drying air temperature may vary from 200° to 275° or more, depending on the temperature of the cottonseed before it enters the drier, the atmospheric temperature, moisture content of the seed, etc. A temperature control with the sensing element located in the drying air discharge is provided for regulating drying air temperatures. A thermometer with the sensing element located in the seed discharge of the drying chamber is provided as a check for temperature to keep the internal temperature of the seed at 140°.

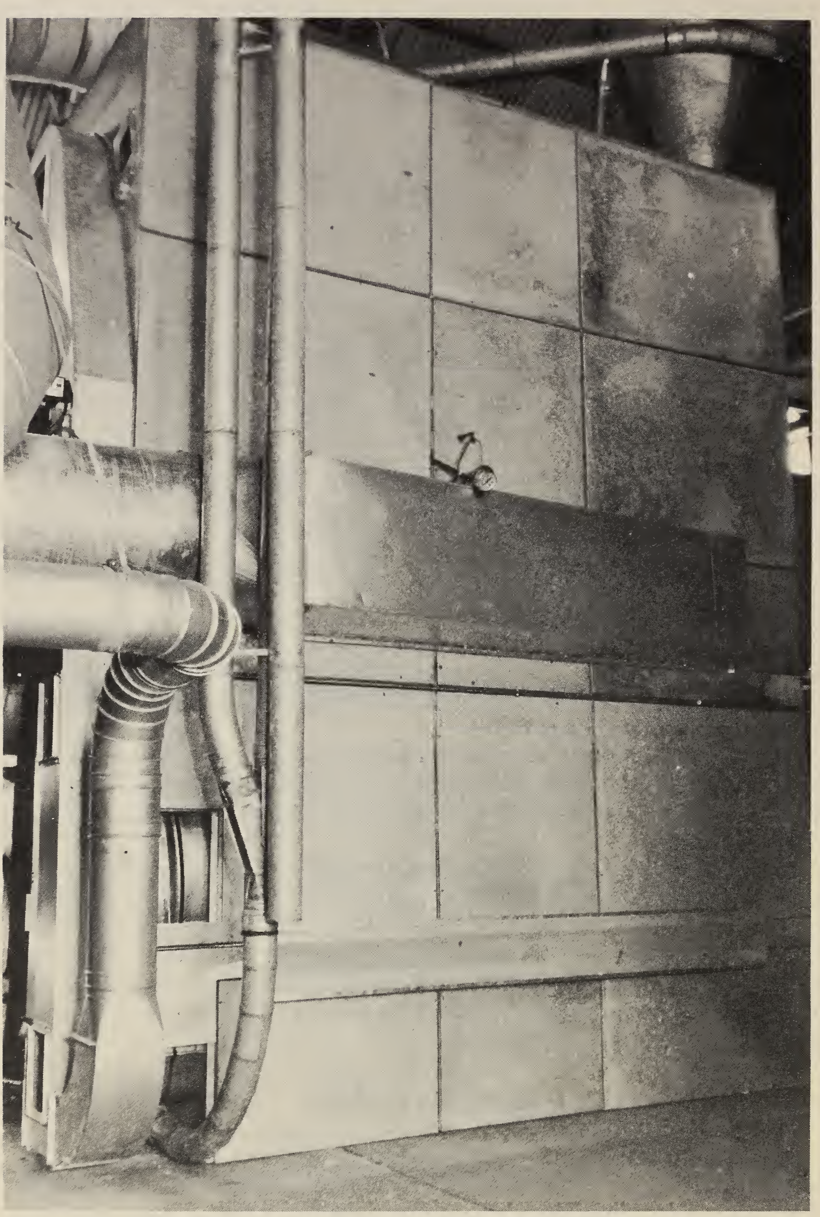

FIGURE 13.—Side view of completed cottonseed drier showing hot-air intake to drying chamber, cold-air intake to cooling chamber, 5-inch seed discharge pipe, and 10-inch trash discharge pipe.

When the internal temperature of cottonseed, having a moisture content of more than 12 percent, is raised above 140° F. for 4 minutes, there is some danger of destroying viability. The 140° internal tem-

perature, for 4 minutes, however, has proved to be entirely safe and does not affect viability. Seed containing less than 12 percent of moisture will withstand even higher temperatures. Tests also show that this optimum temperature for drying does not adversely affect cottonseed oil refining or bleaching quality.

The drying process removes an average of about 3 percent of moisture from seed containing 16.0 percent of moisture. When drying is followed by cooling and aeration of the cottonseed in storage, the additional moisture removed by the cooling and aeration process reduces the seed below the 12.0-percent critical moisture point for safe preservation in bulk storage. It is necessary to cool the seed to atmospheric temperature by aeration following the drying process before bulk storage.

Cottonseed Drier Research Findings

Results of the cottonseed drying and cleaning research show that—

(1) Cottonseed may be dried and cleaned at gins so as to significantly improve grades and corresponding marketing values.

(2) The operation may be conducted concurrently with the ginning process, and at commensurate rates of seed flow.

(3) Artificial drying offers important advantages in the preservation of cottonseed in storage.

(4) Artificially dried cottonseed should be adequately cooled before being left dormant in bulk storage.

(5) Drying at the cotton gin does not stop the development of free fatty acids which might have already started in cottonseed, but drying does retard their progress.

(6) The drying and cleaning of cottonseed before storage provides significant improvement in the grade of cottonseed linters.

(7) Cottonseed drying at the cotton gin offers substantial benefits in preserving seed germination.

(8) Electric energy and fuel costs for drying cottonseed vary according to local rates, but should be substantially less than $1 per ton.

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